Emissions and odour from materials – Harmonisation of test methods

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Research, consultancy and teaching on effects on human health and the environment of exposure to hazardous substances in air, water and soil (occupational, domestic or wider environment).

**IEH Volatiles Laboratory;**
Includes material emissions using FLEC and microchambers, with ATD/GC/MSD, ATD/GC/MS-TOF and SIFT-MS
Me + Plan

• Research, consultancy, policy at BRE, UK Department of the Environment and IEH; since 1982

• Serve on CEN, ISO, BSI and EU expert groups relating to IAQ and emissions.

• Low emitting products
• Test methods; CEN and ISO
• CPD; standard method development
• Labelling schemes; harmonisation of testing and labelling criteria
Indoor pollutant concentration

Concentration of pollutant indoors depends on level in outdoor air, release into indoor air, removal by ventilation, sorption to surfaces and reactions.
Indoor Product Sources

- Volatile organic compounds (VVOC, VOC, SVOC). e.g. formaldehyde, phthalates
- Particles, gases including radon
- Emitted to air and dust
- Airborne and sorbed to surfaces; inhaled and ingested
- Source control combined with appropriate ventilation and outdoor AQ achieves good IAQ
Concerns that increased airtightness of the structure, inadequate ventilation provision and misuse by occupants could result in poor indoor air quality.
Low emitting products

My Definition
A product that does not cause exposure to an agent that adversely affects the health and well being of building occupants.

Issues
- Inadequate knowledge of exposure and health for many agents
- What level of risk
- Protection appropriate for children, elderly, sick and healthy adults.
- Different standards appropriate to building type?
- Is it the product or its conditions of use that are the problem
- Accounting for presence of multiple products
- Product must still perform
- Marketing tool or health benefit
Testing formaldehyde emission from wood based products - ECA 1989 (report no. 2)

- Conditions 1ach, 23°C, 45%RH,
- Loading ratio of 1 m$^2$ m$^{-3}$
- Determine steady state concentration
- Minimum test period of 10 days and maximum of 28 days
- Evolved into standard EN 717-1 for wood based products
- No VOC measurements
Formaldehyde concentration in 1m$^3$ chamber
Testing of VOC emissions from materials – ECA 1991 (report no. 8)

- Expert EU group recommendations
- Environmental test chamber characteristics
- Air sampling and analysis
- Recommended test conditions:
  - 0.5 or 1 ach, 23°C, 45%RH
- Realistic product loadings e.g. flooring 0.41 m².m⁻³
- Reporting of emission rate mg m⁻² h⁻¹
- Screening tests (microchambers)
Development of standards

- ECA on IAQ round robin studies of chamber testing (1993-1999) and proposed a system of evaluating emissions using flooring as an example (ECA report 18 in 1997)
- CEN TC 264 WG7 initiated work to develop standards on emissions of VOCs from building products in 1993
- In 1999 ENV 13419 parts 1-3 published on emission testing using chambers and cells
- Subsequently revised and published as EN ISO standards in 2006
- ISO TC 146 SC6 WG3 developed analytical method standard for VOCs; ISO 16000-6: 2004
Horizontal test standards

- EN ISO 16000-9; Emission test chamber
- EN ISO 16000-10; Emission test cell method
- EN ISO 16000-11; Sampling, storage of samples and preparation of test specimens
- ISO 16000-6; Measurement of VOCs in indoor and chamber air
EN ISO 16000-9 & 10

- 23°C, 50%RH
- Requirements for control of conditions and recovery of released chemical
- Minimum requirement for sampling of chamber / cell after 3 and 28 days
- Informative annex defining model room (17.4 m³, 0.5 ach⁻¹) and area specific air flow rate for product types
Measurement of VOC in indoor air and chamber air by pumped sampling using Tenax TA adsorbent tube and analysis by thermal desorption / gas chromatography with FID/MS detection

- Individual VOC
- TVOC (C6-C16)
- TVOC FID and TVOC MS
- VVOC and SVOC outside TVOC range
ISO 16000-6 review

- Currently in review process (FDIS vote)
- Proposed informative annex (D) on determination of VVOC and SVOC
- Provides advice on appropriate sorbents for VVOC and SVOC including multi-sorbent tubes
Investigation of carry-over of VOCs using optimised desorption conditions

<table>
<thead>
<tr>
<th>Compound</th>
<th>Mean % carry-over</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>in system</td>
</tr>
<tr>
<td>Butylated hydroxyanisole</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>Diethyl phthalate</td>
<td>0.3</td>
</tr>
<tr>
<td>Dibutyl phthalate</td>
<td>0.3</td>
</tr>
<tr>
<td>DEHP</td>
<td>0.9</td>
</tr>
</tbody>
</table>

Amount of benzene released from blank Tenax tubes desorbed at different temperatures

Brown and Crump, 2011
Other relevant EN and ISO standards on chamber air analysis

- **EN ISO 16000-3**
  Measurement of aldehydes in indoor air (pumped)

- **EN ISO 16017-1**
  Guidance on methods of VOC measurement in air (pumped); details available absorbents appropriate for VVOC and SVOC as well as VOC range defined by ISO 16000-6; 2004
EN13999; Emission test of low solvent adhesives

- Part 1: Chamber test
- Part 2: VOC determination
- Part 3: volatile aldehyde determination
- Part 4: volatile diisocyanate determination

- Chamber >4 L
- Loading 0.4 m²/m³
- 0.5 ach
- Sample at 1, 2 and 10 days
- Determine specific emission rate; individual VOC and carcinogens
- Determine cumulative TVOC emission (1 to 10 days)
Resilient, textile and laminate floor coverings

- BS ISO 10580 – Test method for emission of VOCs
  - Emission test chamber (20 – 1000 L)
  - 23°C 50%RH
  - Determine specific emission rate (0.4 m²/m³ and 0.5-1 ach)
  - TVOC and individual VOC, plus formaldehyde (as 16000-6 and 16000-3)

- Test duration (depends on purpose of test)
- Informative annex on evaluation systems:
  - Europe; TVOC at 3 days and TVOC, carcinogen and ‘assessable VOC compounds’ (R value) at 28 days
  - N America; modelled indoor concentration compared to Cal/EPA list of toxic air contaminants and associated limit values. Also volatile aldehydes and carcinogens
Other emission related standards

- **BS ISO 16000-23:2009**: Performance test for evaluating the reduction of formaldehyde concentrations by sorptive building materials.
- **BS ISO 16000-24:2009**: Performance test for evaluating the reduction of VOC (except formaldehyde) concentrations by sorptive building materials.
- **ISO/DIS 16000-28**: Sensory evaluation of emissions from building materials and products.
- **ISO NP16000-31 (new WI)**: Measurement of organo-P.
VOC measurement of car cabin air quality

- ISO TC 22 / TC146 SC6 WG13 joint committee
- ISO DIS 12219-1
- Pumped sampling of VOCs in cabin air with vehicle in test chamber under simulated parking and driving conditions
  - Part 2; Bag method
  - Part 3; microscale chamber
  - Part 4; small chamber
  - Part 5; static chamber
  - New WI; SVOCs/fogging

Figure 1: Overview of test chamber
Construction Products Directive

- Essential Requirement No.3; Hygiene, Health and the Environment
- A healthy indoor environment can be achieved by controlling sources and by eliminating or limiting the release of pollutants into the air
Mandate M/366 features

- Product emissions under normal conditions of use
- Test methods have horizontal character, wherever possible
- Methods validated; robustness and variability-uncertainty for each product group
- CEN standard committee TC 351 formed in April 2006
- WG on radiation now also active
Draft harmonised standard (March 2009)

- Strongly based on the EN ISO standards but some differences and additional guidance and requirements
- Requires use of chamber method as reference method with some limits on chamber parameters (>20 L volume)
- Reference room (30m$^3$) relating emission rate to concentration
- Recognises method can determine >C16 to C22
- Informative annex on VVOC (and SVOC)
- Recognises EN717-1 for testing formaldehyde emission from wood based products under existing regulations
- Enables use of indirect methods
Required reporting

Specific emission rates and concentration in the reference room air of:

- identified target compounds,
- identified non-target compounds
- non-identified compounds (as toluene equivalent)
- carcinogenic substances (>1 µg m\(^{-3}\))
- TVOCSUM (toluene equiv.)
- TSVOCSUM (toluene equiv.

Product evaluation

System of product evaluation to be defined (role of CEN, Commission and EGDS). Classes likely, perhaps as currently used for formaldehyde release from wood-based products:

- E1 <0.1 ppm in chamber test
- E2 >0.1 ppm.
Indirect methods

- Clause 11
- Simpler methods (easier/cheaper)
- Methods provide within field of application a result comparable or correlated to reference method
- Especially can be used for FPC
- Informative annexe gives examples: emission cell, microchambers
Development of screening methods; Bag and CTE, example study

Chromatograms showing compounds emitted from a carpet tile using bag sampling at (a) 40 °C and (b) 60 °C

Number of target compounds emitted from carpet tile identified using different processing techniques; TV = Target View
Validation of draft harmonised standard

- ‘Existing knowledge’ review drafted and discussed at May 2011 meeting of TC 351 WG2; identifies evidence for influence of test parameters on emission test performance and identifies aspects requiring further data.
- Robustness testing; experimental work aiming to confirm values for some defined test parameters.
- Draft report of robustness test programme for review by WG2 in March 2012.
- Validation (reproducibility and repeatability) task; to be undertaken on final draft standard.
Robustness testing

9 emission test laboratories

• **Temperature and humidity;** tests of VOC and HCHO emission from 6 materials at 3 temperatures and constant absolute RH and 3 RHs at constant temperature.

• **Chamber size;** 4 chamber sizes used to test 2 materials (uniform loading etc.)

• **Sealing of edges and rear surface;** various arrangements using 2 materials.

• **Loading factor and ventilation;** 3 materials and 3 different sized chambers. For each combination, 3 loading factors (air change constant), 3 air change rates (loading constant) and 3 tests with constant area specific flow rate but changes in loading and air change rate.

  - 1 liquid product tested at 3 different air velocities.

• **Solid reference material;** all laboratories perform 3 day emission test
Main EU labelling schemes

Schemes
- AgBB, Germany
- M1, Finland
- DICL, Denmark
- AFSSET and Anses, France

Common features
- Chamber test of product to determine chemical emission rate
- Tests based on ISO 16000 (3, 6, 9, 10, 11) series standards
- Evaluate after 28 days (but some schemes have additional evaluation points)

Also many differences
- e.g. TVOC, individual VOCs, formaldehyde, carcinogens, sensory test, LCi.
M1 scheme in Finland

• Uses chamber testing
• Evaluation only after 28 days
• Tests for TVOC, carcinogens, the irritants formaldehyde and ammonia
• Involves sensory evaluation for acceptability and odour intensity
• No pre-assessment of product composition, emissions after 3 days, single VOC (except carcinogens), unidentified VOC, SVOC.
DIBt / AgBB scheme - Germany

- Assessment of construction products used internally according to Health aspects
- Step 1 registration and evaluation of ingredients
- Step 2 testing and evaluation of VOC and SVOC emissions
- Chamber tests with thresholds for TVOC, carcinogens, ‘compounds of interest’ and other ‘non-assessable’ compounds
- Assessment 3 days and 28 days after product placed in chamber
- Aim is for low emission products for healthier buildings in whole of Europe. Notified regulation for flooring products.
Examples of other labelling of low emitting products

- Blue Angel scheme includes furniture, computers, televisions.
- GUT scheme for carpets (industry scheme based in Germany)
- EMICODE for adhesives (industry scheme based in Germany)
- Nordic Swan e.g. flooring
Harmonisation of emission labelling

• In 2005 preparatory group prepared comparison of existing scheme (ECA report 25)
• ECA report no.27 (2011); a road map to harmonisation.
• JRC, Ispra established steering / consultation group to continue the harmonisation process
### Consensus of EU Labelling Harmonisation group

<table>
<thead>
<tr>
<th>Requirements / Parameter</th>
<th>Consensus</th>
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</thead>
<tbody>
<tr>
<td>Measuring method / Chamber</td>
<td>Harmonised CEN Standard (based on ISO 16000 series)</td>
</tr>
<tr>
<td>Measuring points (days)</td>
<td>3 and 28</td>
</tr>
<tr>
<td>Core criteria</td>
<td></td>
</tr>
<tr>
<td>Single VOC evaluation (R = (\sum \frac{C_i}{LC_i} &lt; 1))</td>
<td>R &lt; 1&lt;br&gt; Harmonised list of LCI to be checked</td>
</tr>
<tr>
<td>Carcinogens&lt;br&gt; EU carcinogens (cl.1 and 2)</td>
<td>Harmonised list to be checked</td>
</tr>
<tr>
<td>TVOC measured</td>
<td>200-1000 µg/m(^3)</td>
</tr>
<tr>
<td>Formaldehyde measured</td>
<td>Value to be discussed</td>
</tr>
<tr>
<td>Optional criteria</td>
<td></td>
</tr>
<tr>
<td>Compounds without LCI assessment</td>
<td>Sum &lt; 100 µg/m(^3)</td>
</tr>
<tr>
<td>TSVOC measured</td>
<td>Await validation TC 351</td>
</tr>
<tr>
<td>Sensory evaluation</td>
<td>Await ISO 16000-28</td>
</tr>
</tbody>
</table>
Decision tree for choice of LCI setting basis

**Germany AgBB** (170 LCI, 2010)

1. German or EU-OEL

2. OEL other EU-countries

3. MAK (DFG) or TLV®-Wert (ACGIH) or WEEL-Wert (AIHA)

4. Analogy to similar substance classes

**France AFSSET** (165 LCI, 2009)

1. Indoor Air Guideline Values (IAGV) (France, Index, AQG WHO)

2. IAGV other institutions

3. OEL: EU, France, Germany, ACGIH (USA), other EU-countries

4. Analogy to similar substance classes
Concluding remarks

- Considerable range of ISO and EN standards on measuring formaldehyde, VOC, and SVOC emissions, including for car trim products. Need for simpler tests correlated with chamber method.

- Proposed harmonised method for construction product emission measurement adapts ISO methods for product evaluation under the CPD.

- ‘Voluntary’ Emission Labelling schemes also based on ISO methods and requirements are expected to converge.

- Future work likely to address harmonisation of sensory tests.

- Work on-going to harmonise EU labelling schemes and establishment of EU LCI values is a core need.

• **ECA (2011).** Harmonisation framework for indoor material labelling schemes in the EU. European Collaborative Action report No.27, JRC-Ispra.


• *Brown V and Crump D (2010)*. Control of chemical emissions from construction products. Annual UK Review meeting on outdoor and indoor air pollution research, Cranfield University, IEH web report.
Harmonisation of target compounds and limit levels in EU

S. Kephalopoulos (EC, JRC-IHCP), O. Geiss (EC, JRC-IHCP), P. Harrison (IEH, Cranfield University, UK), D. Crump (IEH, Cranfield University, UK), C. Däumling (UBA, Germany), C. Rousselle (ANSES, France)
AIM OF HARMONISATION

To establish and enable the implementation of a harmonised framework for labelling of building materials and products in the context of safe, healthy, energy efficient and sustainable buildings within the EU.
Workshop on “Harmonised framework for indoor material labelling schemes in EU: challenge with global perspective”, 7-8 June 2010, Somma Lombardo (Italy)

100 participants:

- DG ENTR, DG SANCO
- JRC (IHCP, IPSC, IPTS)
- Existing labelling schemes in Europe, USA, Canada and China
- Industry partners from various building sectors and their European federations
- Governmental organisations
- Standardisation bodies and NGOs
Implementation process:

✓ In liaison with other initiatives impacting the indoor environment (e.g. international activities, the Energy Performance of Buildings Directive, the Construction Products Directive, etc) and the relevant Commission Services (DG ENTR, DG SANCO, DG ENV, DG ENER, JRC)

✓ In close collaboration with the EU Expert Group on Dangerous Substances (EGDS) and standardization bodies (CEN TC351, ISO TC 146/SC6, CEN TC 350)

✓ This activity fully fits to and is a first demonstrator of the JRC Platform/Task Force on “Safe, Health, Energy Efficient and Sustainable Buildings in EU” under conceptualisation
Harmonisation Framework

1st wave criteria
- Single volatile compounds, LCI-values
- Total amount of VOC’s
- Carcinogens

2nd wave criteria
- Sensory evaluation
- SVOC’s
- Other substances

ISO 16000-series

CEN TC351
RESOLUTION 1:

- This conference welcomed the progress made by the preparatory harmonisation group set out in ECA report 27.
- Recommended the setting up of an enlarged WG to further the harmonisation along with task groups for the following specific tasks:
  1. To establish a common open list of substances of concern with appropriate LCI values
  2. To formulate a list of carcinogens that should be evaluated to complement the LCI list
  3. Definition of classes and TVOC + upper limit of TVOC
  4. To review options for sensory testing taking account of work in ISO
RESOLUTION 2:

To setup a new enlarged group (incl. representatives of Member States, Industry and other stakeholders) should work in close collaboration with EGDS, TC 351, ISO TC146 SC6, TC 350 in order to define a roadmap, performance classes, socioeconomic impact and to coordinate with other initiatives impacting the indoor environment e.g. International activities, CPD, EPBD, Commission Services (DGs ENTR, SANCO, ENV, ENER, JRC) and to work out possible implementation approaches.
Workshop on “Harmonisation of the health based evaluation of emissions from building products in the EU using the LCI-concept”, 13-14 September 2010, Ispra

42 participants:

✓ Follow-up of the recommendations of the Workshop of 7-8 June 2010, Somma Lombardo

✓ To setup a European expert group for establishing common European limit values on emissions from building products (LCI-values), drawing on European expertise in toxicological evaluation of chemicals and health standard development
Resolutions:

1. Devise a harmonised procedure for establishing a list of compounds and LCI values (including consideration of carcinogens) for the evaluation of emissions from building products taking into account existing procedures used in some Member States and to recommend an appropriate health-protective, science-based, transparent, and yet pragmatic approach.

2. Propose a flexible framework that enables future review of the procedure to take into account new knowledge (e.g. data from REACH implementation process) and revise the content of the LCI list both in term of number of compounds and LCI values.

3. Establish LCI values for compounds on the LCI list.
DG ENTR

Ad Hoc Group on Classes for Dangerous Substances (AHGC)

AHGC – LCI (draft) list:
- German notification
- French notification
173 regulated substances of which 5 with differing values

AHGC – LCI (draft) list:
- German notification
- French notification
168 regulated
5 harmonised

2010

2011

2012

DG SANCO - JRC

EU LCI group

(Re-)evaluation of:
Toluene, Xylene, Ethylbenzene
Styrene, Tetrachloroethylene

1. Development of Standard Operating Procedures for LCI establishment

2. Apply SOP to draft LCI List & validate

3. Gradually growing harmonised EU-LCI list

Approval by national authorities in EU MS

173 interim LCI for use in CEN classes
• A preparatory EU-LCI working group has been established by DG JRC who is co-ordinating the EU-LCI harmonisation work on behalf of DG SANCO and in close liaison with the DG ENTR’s EGDS ad hoc group on classes.

• In the three meetings held so far (March, July and September 2011) the group has drafted documents on ‘Principle and rationale for the establishment of EU-LCI values’ and ‘Protocol for the de novo derivation of EU-LCI values’

• The WG experts are applying these initial draft procedures to a prioritised list of compounds and knowledge gained is being used to further improve the draft procedures

• The outcome of the preparatory WG will be used as the basis for the setting of harmonised EU-LCI values which will be formally undertaken by a broader group (EU-LCI Committee) to be established by DG JRC in early 2012. Members of the EU-LCI will be: experts nominated by the EU MS, members of the EU-LCI preparatory WG, representatives of the German NIK Committee and the French ANSES Committee, the chemicals industry and WHO.
For more info on the EU-LCI process please contact DG JRC:

Stylianos Kephalopoulos (EU-LCI co-ordinator)

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